Sensor-based Prognostics to Avoid Runaway Reactions & Catastrophic Ignition (SPARRCI)

National Aeronautics and Space Administration

Ensuring Safe, Reliable Power for Electric Aircraft

Challenge

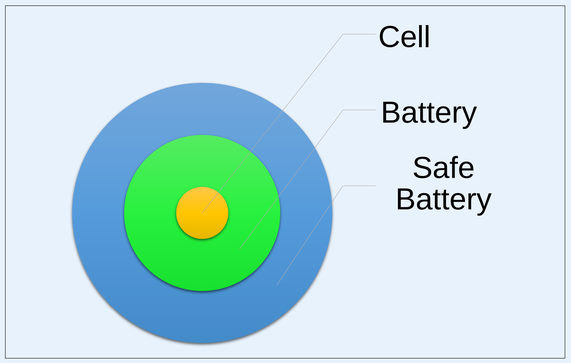
- Electric aircraft concepts require high power and high energy storage, but they must also be SAFE!
- State-of-the-art batteries suffer from catastrophic failures, resulting in over-engineered, heavy failure solutions to provide safer energy storage
- Existing solutions aim to contain or prevent thermal runaway propagation at a battery level, but single-cell events cannot be predicted

Expected Impacts

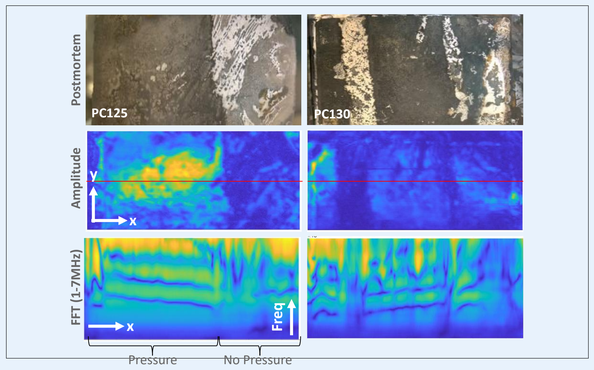
- With early detection of failure, we ensure catastrophic failures are eliminated and the result is a safe, higher energy battery to enable next-generation electric aircraft concepts
- Next-generation battery chemistry development occurs on a long timeline and may offer higher specific energy but not additional safety
- SPARRCI offers a shorter timeline to implement new chemistries with a better understanding of safety

Solution

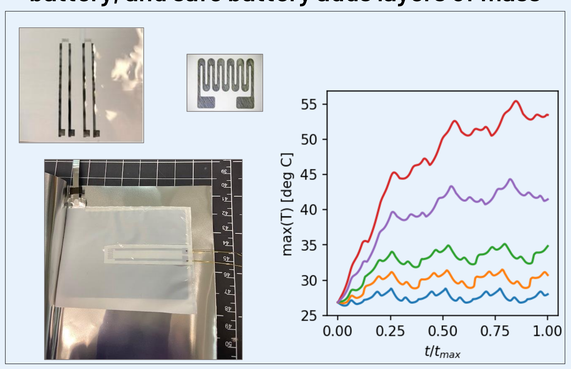
- SPARRCI offers a multi-disciplinary approach combining battery failure analysis, nondestructive evaluation (NDE), sensor development, and modeling & prognostics for early failure detection
- Using embedded sensor and NDE data fed into models, failures can be predicted based on changes in cell function or material morphology
- Enabling for higher energy, safer aircraft batteries for existing chemistries and shortening the timeline for future development



Turning a chemistry into a cell, packaged battery, and safe battery adds layers of mass



Battery failure analysis pairs with UT NDE techniques, showing sensitivity to defects



Embedded sensors provide higher quality data to improve fidelity of off-nominal models

SPARRCI offers decreased weight, increased safety, and improved aircraft performance

Results

- Using shadow mask and photolithography, sensors are printed onto battery materials & provide valuable internal data when embedded in pouch cells
- NDE techniques such as digital radiography and ultrasound, and laser doppler vibrometry can detect material defects
- Advances to battery performance models predict off-nominal behavior

Next Steps

- Demonstrate benefit of data from combined sensor + NDE techniques during nominal and off-nominal cell behavior
- Integrate concepts into battery pack-level NASA projects
- Address optimization of sensor connections, data collection, and modeling/prognostics fidelity

Partners and/or Participants

- NASA Glenn Research Center, batteries/sensors
- NASA Langley Research Center, NDE
- NASA Ames Research Center, modeling & prognostics
- Cornerstone Research Group, small business partner

POC: Brianne DeMattia, NASA Glenn Research Center

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